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Short Communication

Sleeping site sharing between *Aotus griseimembra* (Mammalia, Primates) and *Coendou quichua* (Mammalia, Rodentia) in a lowland inter-Andean valley in Colombia

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Abstract

Tree cavities used as sleeping sites are a limited resource for arboreal mammals. The shared use of arboreal cavities as sleeping sites between Neotropical mammals is rarely observed and has been little studied. We documented an event of sleeping site sharing between two medium-sized mammals, the Caribbean night monkey (*Aotus griseimembra*) and the Quichua porcupine (*Coendou quichua*), recorded in the humid lowland forests of the inter-Andean basin of the Magdalena River in the eastern part of the Department of Caldas, Colombia. The sleeping site sharing occurred in an avocado tree (*Persea americana*) over a period of three days and included an agonistic encounter between the two species. The group of Caribbean night monkeys was always near one of the two cavity entrances, entering near sunrise and leaving near sunset, while the two Quichua porcupines were inside the cavity, in different positions, and remained in the sleeping site even after dusk and before dawn. This study provides new information on the interaction between night monkeys and porcupines, and on the sharing of tree cavities as sleeping sites.

Key words: Aotidae, Erethizontidae, Magdalena basin, natural history, *Persea americana*, Sleeping site

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Introduction

Sleeping sites are critical spatial resources that may influence the survival and reproductive success of an organism, allowing it to rest during periods of reduced activity while they are most vulnerable, and providing safety from predation and extreme weather conditions (Day and Elwood 1999; Kunz and Lumsden 2003; Lutermann et al. 2010). Sleeping site selection is influenced by both biotic and abiotic factors, such as interspecific and intraspecific competition, predation, or parasites, as well as climatic factors (Anderson 1984). For mammals, several categories of sleeping sites have been described, ranging

from open areas in vegetation to natural cavities, artificial structures, and self-constructed nests or burrows (Anderson 1998; Gibbons et al. 2002; Kunz and Lumsden. 2003; Karanewsky and Wright 2015). For arboreal mammals, tree cavities are important because they provide refuge in the same forest stratum in which they live (Gibbons et al. 2002; Lindenmayer et al. 2017; Patel et al. 2021; Terry et al. 2021). However, cavities in trees might be a limited resource in forests, which can lead to interactions and competition both within and between species (Birks et al. 2005; Veiga et al. 2013; Ibarra et al. 2017; Terry et al. 2021). Interspecific interactions in the use of cavities for sleeping site can lead to direct agonistic encounters or to tolerance, either by co-occupation of different cavities in the same tree or by co-habitation of the same cavity (Aquino and Encarnación 1986; Puertas et al. 1995).

Two of the most recognized orders of arboreal mammals in Neotropical forests are primates and rodents (Kays and Allison 2001). Both mammal taxa are characterized by a high diversity of species and arboreal behaviors (Rylands et al. 2000; Poux et al. 2006; Fernandez-Duque et al. 2012; Amori et al. 2013; Upham et al. 2013; Ojeda et al. 2016; Álvarez et al. 2017). Night monkeys (genus *Aotus*) and nocturnal rodents such as porcupines of the genus *Coendou* are of particular interest (Puertas et al. 1995; Barthelmess 2016), as they have a wide geographic distribution in the Americas, occupying different types of forests (Voss et al. 2013; Voss 2015; Barthelmess 2016; Shanee et al. 2023). Night monkeys are distributed from Panama to Argentina, and from sea level up to 3,000 m in the Andean region (Defler 2010; Shanee et al. 2023). Similarly, porcupines, range from Mexico to Uruguay, but at elevations from sea level up to 3,650 m (Voss et al. 2013; Voss 2015; Barthelmess 2016; Brito and Ojala-Barbour 2016). Night monkeys have the highest species richness in Colombia, with 8 of the 12 described species to date (Fernandez-Duque et al. 2023; Shanee et al. 2023), while the highest number of porcupine species is concentrated in Brazil with 10 species, and also in Colombia with 6 of the 16 currently valid species (Voss 2015; Barthelmess 2016; Ramírez-Chaves et al. 2016; Menezes et al. 2021).

A common feature between night monkeys and porcupines is the lack of knowledge regarding habitat use and specific characteristics related to diurnal sleeping sites. Although night monkeys are known to sleep primarily in tree hollows and dense clumps of vegetation, there are only specific reports for *Aotus nancymaae* and *A. vociferans* that describe the use of hollows and cavities in tree branches, clumps of vegetation (epiphytes, climbers, and lianas), and bamboo as sleeping sites (Aquino and Encarnación 1986; Puertas et al. 1995). A few anecdotal observations of *A. vociferans* co-sharing with individuals of several mammal species, including *Coendou bicolor*, have also been described (Aquino and Encarnación 1986; Puertas et al. 1995). In the case of porcupines, almost nothing is known about their sleeping sites, and there is only anecdotal evidence documenting their use of tree cavities and branches (Emmons and Feer 1997; Voss 2015; Barthelmess 2016). Regarding the sharing of different cavities as sleeping sites in the same tree and the same cavity with other mammals, only the reports of sleeping arrangements between *C. bicolor* and *A. vociferans* are known to date (Aquino and Encarnación 1986; Puertas et al. 1995).

The Caribbean night monkey, *Aotus griseimembra* and the Quichua porcupine, *Coendou quichua*, share a common distribution in the inter-Andean Magdalena River Basin and the Caribbean Region of Colombia (Ramírez-Chaves et

al. 2016; Shanee et al. 2023). We report a sleeping site sharing event between the two species recorded in an ecotourism farm in the Magdalena River basin in the eastern part of the Department of Caldas, Colombia.

Methods

The sleeping site sharing was documented on March 18, 2024, at La Camelia farm (5°20.55'N, 74°54.03'W, ~ 650 m a.s.l.), located on the eastern slope of the Central Cordillera of Colombia, in the municipality of Victoria, Department of Caldas, Colombia (Fig. 1). The landscape at the study site is comprised of small-scale crops of avocado, cacao, banana, plantain, citrus, and cassava, and fragments of forest with isolated trees that provide shade for some of these crops.

The sleeping site sharing event took place in the usual sleeping site of the group of Caribbean night monkeys (used for over eight years by the same group), which corresponds to a cavity approximately 2.5 m long, located in an avocado tree (*Persea americana*) about 10 m high.

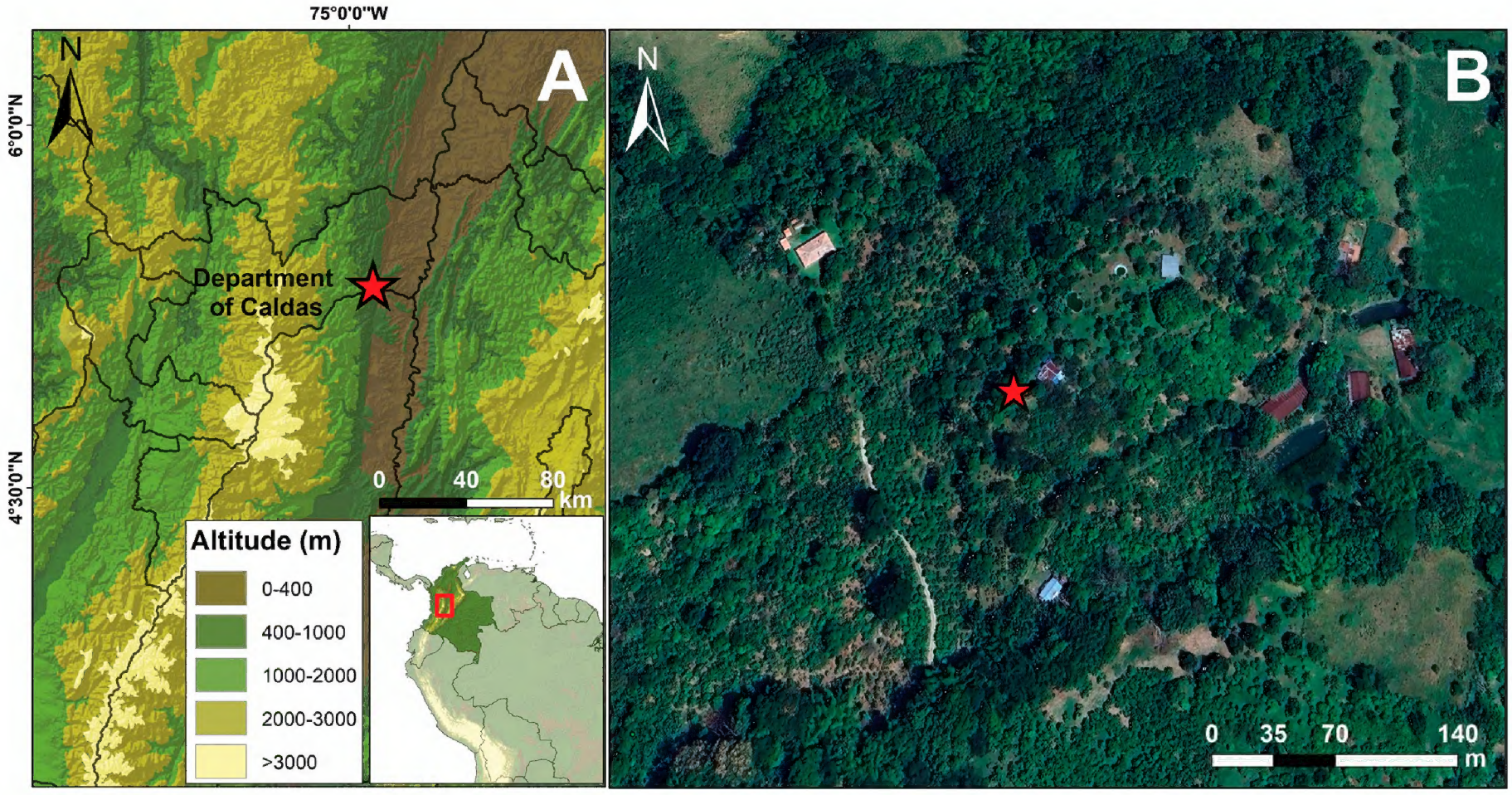

Figure 1. Geographic location where we report sleeping site sharing between Caribbean night monkeys (*Aotus griseimembra*) and Quichua porcupines (*Coendou quichua*) **A** geographic location of La Camelia farm in Victoria, Caldas, Colombia **B** Satellite image of La Camelia farm and the location of the sleeping site (red star).

Considering the lack of morphological differentiation between the *A. lemurinus* species complex (comprising *A. griseimembra*, *A. lemurinus* and *A. zonalis*), we relied mainly on the geographic location where the observation was made to identify the night monkeys as *A. griseimembra* (Defler 2010). In the Middle Magdalena River Basin, *A. griseimembra* is the night monkey species found below 1,000 m a.s.l (Defler 2010; Shanee et al. 2023). To identify the porcupines as the species *C. quichua*, we considered the following external traits (Voss 2011; Ramírez-Chaves et al. 2016): medium-bodied (around 300 mm), long-tail (around 250 mm), completely spiny and lacks long fur, quills bi-tricolored with lighter base followed by a dark middle part and a lighter (whitish) distal band. The muzzle is inflated but not elevated (Racero-Casarrubia et al. 2016).

Tree cavity description

The avocado tree cavity where we observed the sleeping site sharing has two entrances; the lower entrance is located about 3.5 m above the ground and has a width of approximately 25 cm and a height of approximately 80 cm. The upper entrance is located about 6 m above the ground and has a width of approximately 30 cm and a height of approximately 40 cm (Fig. 2). The two entrances connect the cavity to the outside of the tree, and it is common to see the group of Caribbean night monkeys (an adult male, an adult female, and one subadult and one juvenile of unknown sex) resting in one of the entrances during the day.

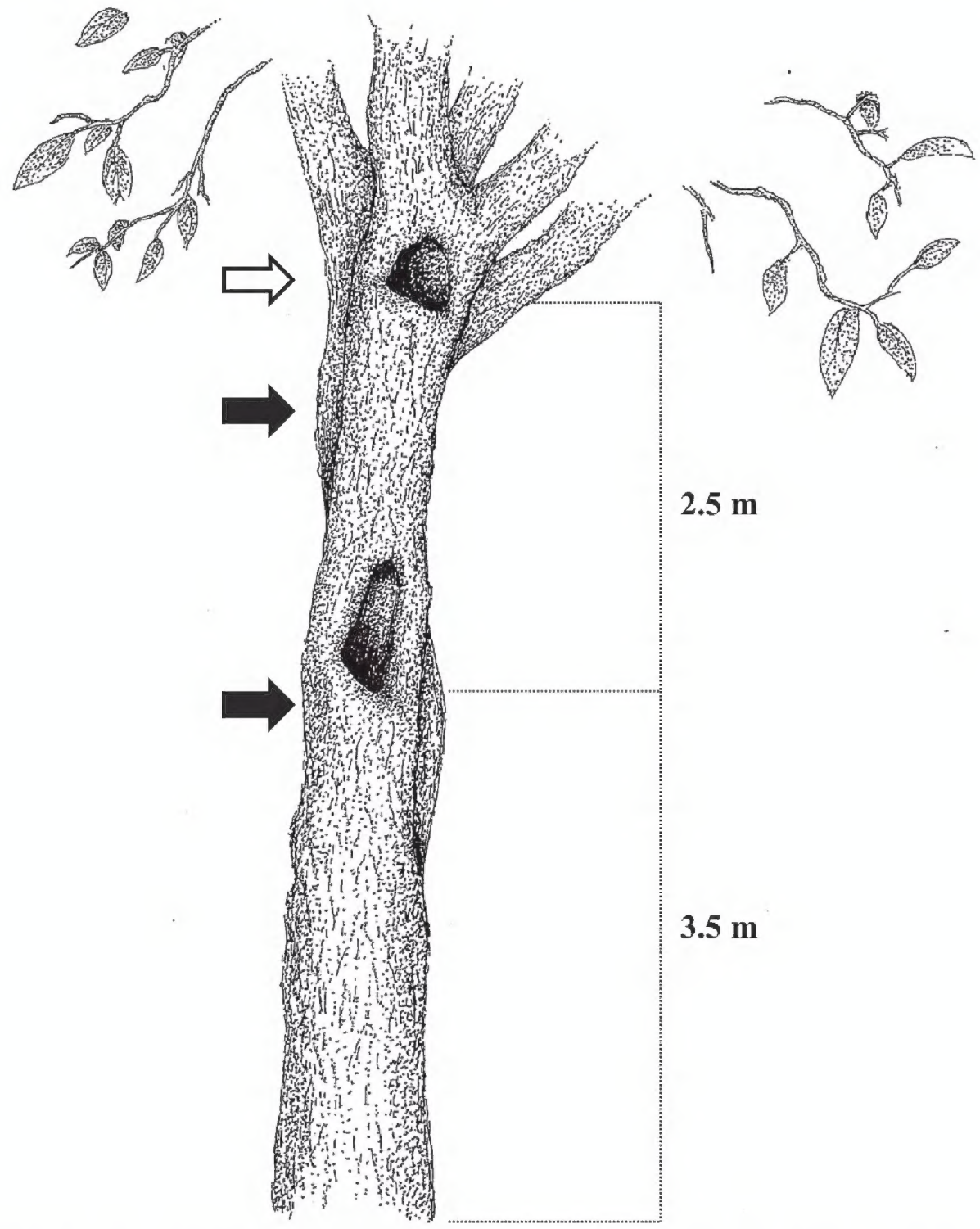

Figure 2. Illustration of the avocado tree (*Persea americana*) and the cavity used as a sleeping site. The white arrow points to the entrance where the Caribbean night monkeys (*Aotus griseimembra*) were located. The black arrows indicate the location of the cavity where the Quichua porcupines (*Coendou quichua*) were located.

Results

Interactions

The first observation of sleeping site sharing between the Caribbean night monkeys and the Quichua porcupines occurred while we were waiting for the group of Caribbean night monkeys to arrive at their usual sleeping site at 05 h

45 min. At 5 h 57 min we observed the group of Caribbean night monkeys trying to access the lower entrance of the cavity and saw a Quichua porcupine coming out of the cavity displaying defensive behaviors by using its quills as defense against the adult male Caribbean night monkey who was carrying an infant. The interaction caused the infant to fall to the ground from about four meters. Immediately, the other three individuals of Caribbean night monkeys (adult male, adult female, and subadult) descended to the lower branches of a nearby bush, and the adult male picked up the infant from the forest floor, placed it on his back, and they all climbed back up to occupy the upper entrance of the tree. After the agonistic interaction, the Quichua porcupine entered the lower cavity entrance. When both the group of Caribbean night monkeys and the Quichua porcupine had entered the cavity through both entrances, we left the sleeping site.

At 12 h 39 min, we conducted an inspection of the avocado tree where the sleeping site was located to observe the health condition of the Caribbean night monkey infant after its fall following the agonistic interaction with the Quichua porcupine. At this time, we observed the group of Caribbean night monkeys resting in the upper entrance of the cavity (Fig. 3A). We used a ladder to check if the Quichua porcupine was also inside the cavity and confirmed its presence at the center of the cavity between the upper and lower entrances in a resting position. By inspecting the entire cavity from the lower entrance, it was possible to observe both the Quichua porcupine in the center of the cavity and the silhouette of one individual of the group of Caribbean nigh monkeys in the upper entrance (Fig. 3B).

We returned to the sleeping site at 17 h 45 min to record the departure of both the group of Caribbean night monkeys and the Quichua porcupine. At 18 h 20 min we observed the four Caribbean night monkeys, including the infant on its father's back, emerge from the upper entrance of the tree (Fig. 3C) and move through the upper branches before moving to the neighboring tree where we lost sight of them. Subsequently, at 18 h 23 min, we observed a second Quichua porcupine (different from the one observed in the morning and at noon) moving from the base of the cavity towards the lower entrance (Fig. 3D). Eight minutes later, we observed the first Quichua porcupine (the one resting in the center of the cavity) moving from the center of the cavity toward the lower entrance. Both Quichua porcupines met at the lower entrance at 18 h 36 min (Fig. 3E) and entered the lower part of the cavity where they emitted some vocalizations for 30 seconds. We remained in the cavity until 19 h 30 min and did not observe either the Quichua porcupines leaving the cavity or the group of Caribbean night monkeys returning.

During the three days following the first observation of sleeping site sharing by the two species (until 21 March 2024), we observed the group of Caribbean night monkeys resting during the day at the upper entrance of the cavity. On the same days, we also observed the Quichua porcupines resting at the sleeping site, one in the center of the cavity between the upper and lower entrances and the other at the base of the cavity near the lower entrance. Although sleeping site sharing continued, no further agonistic events between the two species were recorded. On 22 March 2024, only the group of Caribbean night monkeys were observed resting in the lower entrance of the cavity, without the presence of the Quichua porcupines.

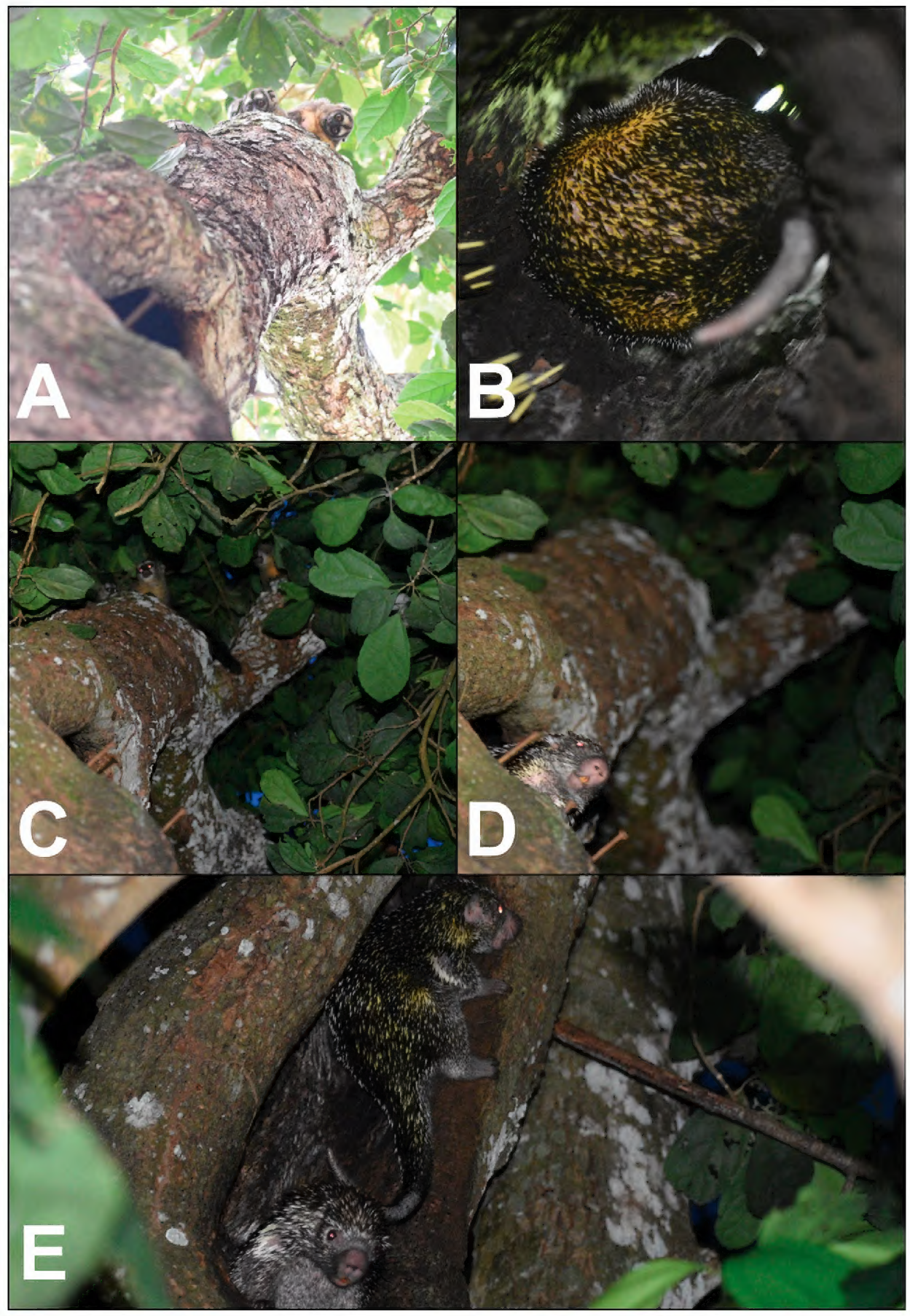

Figure 3. Photograph of sleeping site sharing between Caribbean night monkeys (*Aotus griseimembra*) and Quichua porcupines (*Coendou quichua*) **A** a group of Caribbean night monkeys (*Aotus griseimembra*) resting in the upper entrance of the cavity of the avocado tree (*Persea americana*) **B** one Quichua porcupine (*Coendou quichua*) observed resting in the cavity of the same avocado tree. Note the silhouette of a Caribbean night monkey behind the porcupine **C** photograph of the moment when the group of night monkeys left the cavity to begin their nocturnal activity **D** photograph of the moment when a second porcupine emerges from the base of the cavity and is located at the lower entrance **E** both porcupines at the lower entrance of the cavity.

Discussion

We recorded shared sleeping site use between *A. griseimembra* and *C. quichua*, adding to the information on interactions between Neotropical night monkeys and porcupines, where similar interactions have only been reported between *A. vociferans* and *C. bicolor* in the Peruvian Amazon (Aquino and Encarnación 1986; Puertas et al. 1995). Reports of sleeping site sharing between night monkeys and other mammals include the use of different cavities in the same tree by *A. vociferans* and carnivores such as *Bassaricyon alleni* and *Potos flavus*, mar-

supials such as *Caluromys lanatus*, and rodents such as *Isothrix bistriata*. Other cases of sleeping site sharing between night monkeys and other mammals, such as the one we reported, *A. vociferans* and *B. alleni* (as *B. gabbii*), as well as *A. vociferans* and *P. flavus*, have been reported to share the same cavity (Aquino and Encarnación 1986; Puertas et al. 1995). For porcupines, there are no reports of other sleeping site sharing events with other mammals, other than the case described for *A. vociferans* and *C. bicolor* (Aquino and Encarnación 1986).

Sleeping sites can be limited resources that may influence the lifetime reproductive success of an individual (Day and Elwood 1999; Kunz and Lumsden 2003; Lutermann et al. 2010). Thus, it is expected that both intra-specific and inter-specific competition for tree cavities might take place (Birks et al. 2005; Veiga et al. 2013; Ibarra et al. 2017; Terry et al. 2021) particularly in degraded landscapes where large trees (those usually bearing tree cavities suitable as sleeping sites for arboreal mammals) are scant. We cannot rule out that the interaction between Caribbean night monkeys and Quichua porcupines and the sharing of a tree cavity might be enhanced by the pervasive transformation of forests into agricultural fields in the study area, but the chances are high considering the high level of disturbance of the middle Magdalena natural ecosystems.

Both in the case of sleeping site sharing of *A. vociferans* with *C. bicolor* and with other mammals, Aquino and Encarnación (1986) mentioned that individuals of *A. vociferans* always occupied the part of the cavity closest to one of the entrances, while the rest of mammals slept inside the cavities. We observed the same situation in the sleeping site sharing event between *A. griseimembra* and *C. quichua*, where all individuals of the group of Caribbean night monkeys remained only in the upper entrance of the cavity, while the two Quichua porcupines rested inside the cavity. In another observation by Aquino and Encarnación (1986), *A. vociferans* left the sleeping site 20 to 25 minutes earlier and arrived 15 to 20 minutes later than other animals co-sharing the same tree. Our observations followed the same pattern, with Caribbean night monkeys leaving the sleeping site just at dusk and returning just at dawn, while Quichua porcupines were at the sleeping site after dusk and before dawn. These differences in the amount of time that the two mammals spent at the sleep site may be related to their nocturnal activity peaks, which in turn may be influenced by factors such as ambient light, seasonality, resource availability, among others. In the case of the Caribbean night monkey, greater activity has been reported at dusk and dawn when the availability of ambient light is greater (Montilla et al. 2021; Muñoz-Delgado et al. 2021). In another Neotropical rodent species close related with the genus *Coendou* (i.e., the bristle-spined rat, *Chaetomys subspinosus*), activity was found to increase during the hours after dusk and before dawn when ambient light intensity is reduced (Fernandez-Giné et al. 2011).

In all cases where sleeping site sharing was observed between *A. vociferans* and other mammals, only one agonistic interaction was reported, in which the night monkeys attempted to enter their sleeping site and were displaced by grunts of more than one *P. flavus* individual resting inside (Aquino and Encarnación 1986). In our observation, although we were able to record an agonistic encounter between *A. griseimembra* and *C. quichua*, the Caribbean night monkeys did not change their sleeping site and positioned themselves only in the upper entrance of the cavity, while the two Quichua porcupines used the interior of the cavity. Nonetheless, the fact that the avocado tree had two entrances and a spacious hollow area in the inside might have allowed both species to use the sleeping tree synchronically.

Other interactions between night monkeys and porcupines occurred in the Peruvian Amazon, where individuals of *A. nigriceps* were recorded by trail cameras on two occasions chasing individuals of *Coendou ichillus* (Gregory et al. 2015). Additional interactions of night monkeys with other mammals include a case of possible predation of *A. brumbacki* by *Sapajus apella* in the Colombian Llanos (Carretero-Pinzón et al. 2008) and other agonistic encounters were recorded at feeding sites between *A. lemurinus* and *P. flavus* in the Central Andes of Colombia (Montilla et al. 2021). For porcupines, agonistic encounters with exotic animals such as dogs have been reported for species such as *C. longicaudatus* (as *C. prehensilis*), *C. rufescens* and *C. vestitus* in the Andean region of Colombia (Cortés-Suárez et al. 2021; Rios-Soto et al. 2021; Ramírez-Chaves et al. 2022), as well as a predation event on *C. longicaudatus* by *Leopardus pardalis* in the Peruvian Amazon (Griffiths et al. 2020), and *C. rufescens* by *Puma concolor* in the Andes of Colombia (Muñoz-Castillo et al. 2020; Ramírez-Chaves et al. 2022). Furthermore, information on the natural history of porcupines in Colombia and throughout their distribution is still limited (e.g., Ramírez-Chaves et al. 2020, 2022).

Finally, although there are no specific data for *A. griseimembra* and *C. quichua* on the detailed characteristics of their sleeping sites, it has been inferred that, like their congeners, they use tree cavities to rest during the day (Aquino and Encarnación 1986; Emmons and Feer 1997; Voss 2015; Barthelmess 2016). Therefore, our observations add new information on the specific characteristics of the cavities (tree species, number of cavity entrances and their dimensions) used as sleeping sites by these two species of arboreal mammals.

Conclusion

Our report of sleeping site sharing between *A. griseimembra* and *C. quichua* provides new information on the interactions between night monkeys and porcupines, two diverse groups of arboreal mammals with wide distributions and multiple species in sympatry. Consistent patterns of sleeping site sharing were observed by us, compared to those to *A. vociferans* and *C. quichua* by other researchers in the Peruvian Amazon. These patterns of sleeping site sharing include the use of different spaces in the cavities by the two species and the time when they enter and leave the sleeping site. In addition, this study highlights the ability of Caribbean night monkeys and Quichua porcupines to use exotic plant species such as avocado trees as sleeping sites and provides new information on the characteristics of the cavities used by both species for daytime rest. Finally, this study highlights the importance of understanding species interactions even in anthropogenically transformed landscapes.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Author contributions

Conceptualization: AL, HERC. Data curation: SOM, JDS. Funding acquisition: SOM. Investigation: AL, SOM, HERC, JDS. Methodology: SOM, JDS, HERC, AL. Resources: JDS. Supervision: HERC, AL. Writing – original draft: AL, SOM, HERC, JDS. Writing – review and editing: JDS, AL, SOM, HERC.

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Data availability

All of the data that support the findings of this study are available in the main text.

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